

SENSOR:

Smart Embedded Network of Sensors with Optical Readout

Project Team and Key Personnel



Globally renowned research center in
The Business of Breakthroughs®

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Industry-leading EV battery systems
Supplying Tomorrow's Energy Storage Solutions... Today

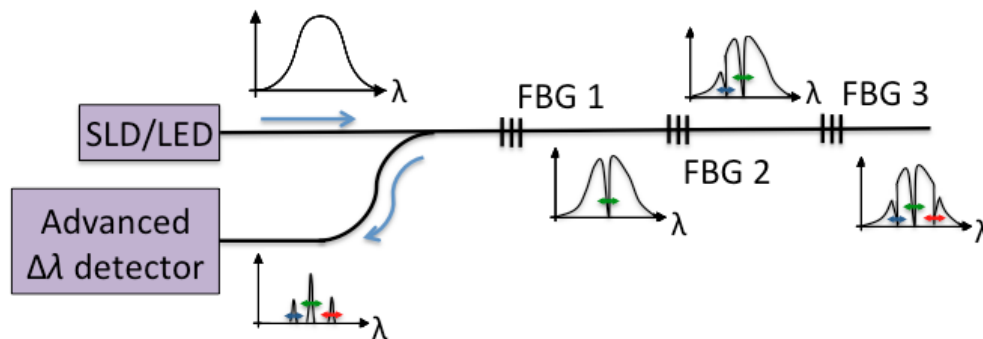
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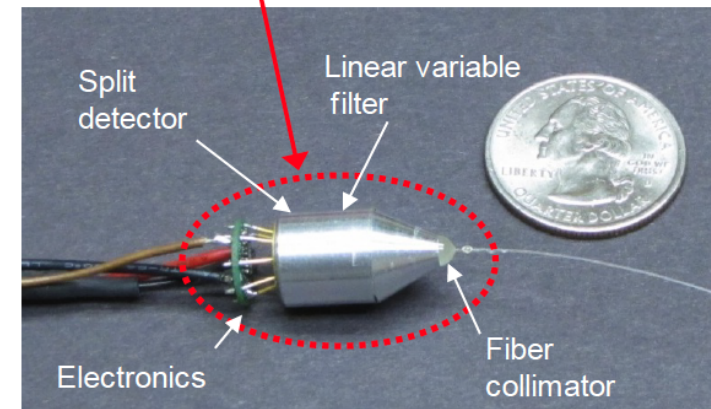
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Fiber Optic Sensors for Internal Cell State

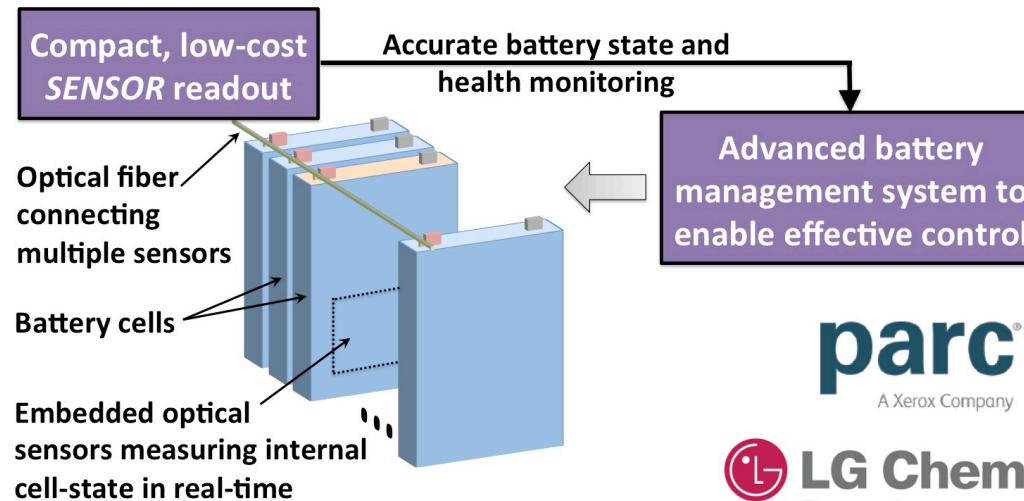


PARC's $\Delta\lambda$ -detector



- Multiplexed fiber optic (FO) sensors a promising option for internal cell monitoring:
 - ▶ Thin, light-weight, robust to harsh environments, EMI
 - ▶ Can measure various BMS-relevant internal cell parameters
- Commercial FO readouts typically bulky, expensive
- *Use PARC's breakthrough low-cost, field-deployable FO readout and intelligent algorithms for BMS*

SENSOR Overview



parc
A Xerox Company

 **LG Chem**
Power Inc.

Technology

- Fiber optic (FO) monitoring system combines embedded sensors and smart algorithms
- PARC-created optical readout ideally suited for battery monitoring
- Intelligent algorithms exploiting sensor network for effective BMS
- LGCPI's manufacturing/validation expertise to ensure EV-grade tech

Advantages/Differentiation

- EV batteries expensive today:
 - Only use external V , i , T readings
 - Very conservative design/safety approaches to compensate
- PARC's low-cost, compact embedded fiber optic sensing to monitor internal cell state during operation
- Allow designers to more fully, safely use battery's true capabilities

Performance Targets and Validation Plan

Metric	State-of-the-art	Targets of Proposed <i>SENSOR</i> Technology	
Internal cell temperature	Up to 30°C (from cell skin temp.)	Internal cell temp. monitoring: 1°C accuracy	Compared against numerical cell models
SOC	5%	2.5% accuracy	
Side-reaction monitoring	No internal sensing	Adverse chemical HF detection up to 50 ppm	Validated experimentally
Cost	Battery oversizing	>25% reduction with 3 to 7% cost overhead (OH)	Technoeconomic cost-performance model to check
Performance overhead	No internal sensing	<0.05% energy density, volume & weight OH	

Industry-standard testing w/ LGCPi's EV-grade cells:

- Seal integrity of cells with embedded FO sensors
- Static, dynamic SOX estimation using *SENSOR* system
- Charge cycling repeatability, environmental stability
- Seeded fault detectability tests

Requests of AMPED Community

- EV OEMs: requirements for *SENSOR* tech?
- Internal cell parameters of interest
- Concerns, suggestions, pitfall warnings
- Validation strategy suggestions for internal cell temperature measurement
- How do these advanced BMS needs map out in other challenging domains, e.g.:
 - ▶ Electric grid storage
 - ▶ Aerospace
 - ▶ Military